

5G: A REVOLUTION IN COMMUNICATION

What is 5G?

5G promises to be a revolution in communication. Wireless technology as we know it has evolved from 1G, which made cordless communication possible, to 2G which made texting possible. Faster network speeds of 3G technology allowed for the introduction of smart phones and transmission of pictures, while 4G has enabled video transmission. 5G, the next generation wireless technology, is considered a breakthrough technology as it is expected to expand wireless communication beyond smart phones to all kinds of different machines. It is critical for the next industrial revolution, the Internet of Things (IoT).

The key features of 5G that will usher in the age of IoT are speed, latency and user density. 5G will have peak speed of 20 giga bits per second (Gbps) which is significantly faster than 4G. It will also have very low latency, which is the time delay between sending a message and receiving it. 5G latency is expected to be 1milli second (ms) compared to 10-50 ms for 4G. Low latency is needed for real time interaction for mobile gaming, virtual reality applications as well as autonomous driving. 5G will allow connectivity for up to 500x more devices per unit area compared to 4G. This is essential for industrial IoT as well as “smart” cities. It will also have 100% coverage and have 99.9% availability (Table 1).

The Internet of Things (IoT) is a system of interrelated computing, mechanical and/or digital devices which can communicate and seamlessly transfer data over a network. The “thing” in IoT is any device with a unique IP address which can transmit/receive data over a network. IoT is expected to change all industries and is considered the next industrial revolution. IoT is expected to generate a lot of data which, along with Artificial Intelligence (AI), can then be used to improve efficiency. For example, manufacturing can become more efficient as companies get better control over their processes and supply chains. Similarly, real time data processing along with AI will allow the service sector to customize products and improve customer service. Cities can be made “smart” by using IoT devices to gather and analyze data needed to improve infrastructure and other public services. For example, cameras mounted on traffic signals can be used to reroute traffic to reduce commute times as well as accidents.

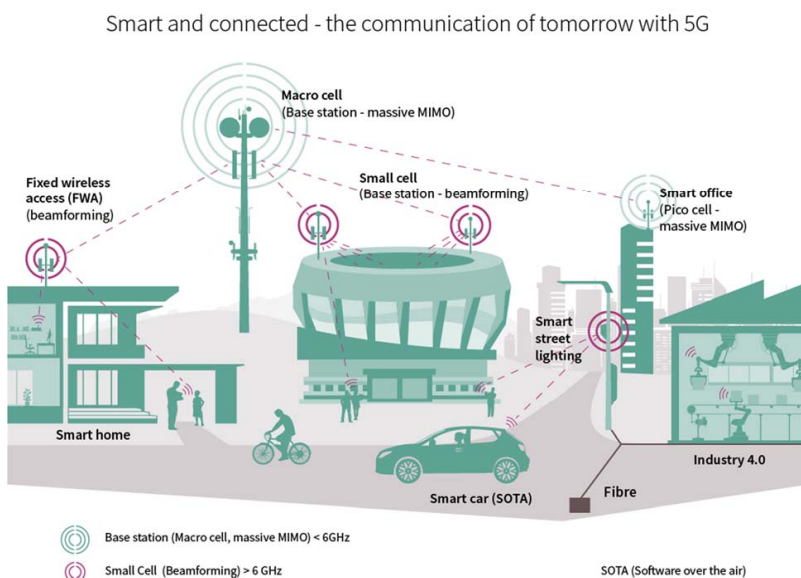
Table 1: Comparison of 4G LTE and 5G NR Standards¹

	Speed	Latency	User Density
5G (NR)	Avg. Speed: 100Mbps, Peak Speed: 20Gbps	1 ms	1 Mil/square Km
4G (LTE)	Avg. Speed: 25Mbps, Peak Speed: 300Mbps	10-50 ms	2000/square Km

The 5G network is being built upon the current 4GLTE network and will combine new technology in order to use a wider spectrum of frequencies for data transmission. 4GLTE uses low band radio frequencies (below 6GHZ), which can travel long distances and can pass through dense materials like walls. Current 4GLTE wireless transmission is done using base towers which transmit signals over long distances. Also, most of these base towers transmit signals to the fiber optic core through microwave transmissions. 5G will ultimately use low, medium and high band radio frequencies (6Ghz -100Ghz). Medium and high band frequencies (mm Waves) have higher speed and are directional which means they can be transmitted without much interference from other radio waves. However, they can travel only short distances and are not highly penetrative. Therefore, small cells are expected to be installed in high use areas like cities or sports stadiums. For optimal 5G delivery, these cells are expected to be 200 to 1000 feet apart. This will lead to densification of the 5G wireless signals. 5G technology will be deployed over both the fiber optic backbone as well as wireless transmission between base stations and small cells. In an ideal 5G infrastructure (Fig. 1), base stations with multiple antennas (multiple input, multiple output, MIMO) will be used to send and receive a radio signal which will be directional or concentrated in a particular direction (beam forming). Densification of this signal, in high population areas, will be achieved by small cells. These small cells will also be used to transmit signal to various devices including smart phones. Small cells will be attached to the fiber optic network backbone.

5G roll out is being done in stages. The first stage, which started in late 2018 (2018-2020 period), will focus on the deployment of additional fiber optic network. Radio deployment will be done on the existing 4GLTE network. Software upgrades to 5G will be done as additional spectrum becomes available. The second stage (2019-2022), is expected to focus on densification using small cells. The final stage (2021-) will see an upgrade from 4GLTE to 5G core and the use of higher frequencies (mm Wave). This will allow for enhanced connectivity and is expected to usher the age of IoT.

Figure 1²



Investment Opportunities

While network carriers are an obvious way to invest in 5G, we will focus on the technology companies that can benefit from the 5G rollout.

5G Network Infrastructure (Table 2): As the transmission of data over the 5G network increases, the need for base stations to transmit this data also increases. The base station antenna market is expected to grow 14% CAGR between 2018 and 2021. Currently, most base stations are connected to the fiber optic core by microwave transmission. However, as 5G starts using higher band width, microwave transmission will not be effective and base stations will have to be connected to the core network by fiber. Also, densification by using small cells in high population areas is key for 5G rollout. The small cell market is expected to grow 25% CAGR between 2016-2021. For optimal 5G delivery, these cells need to be connected to the network backbone using fiber optics. Corning (GLW) is a major supplier of fiber optics cable. Small capitalization fiber optics providers include CommScope (COMM) and Infineon (INFN). COMM is also a supplier of small cells. Cisco (CSCO) is a major supplier of wireless network products like routers, switches and network access points as well as network security software like next generation firewalls and VPN security. Juniper Networks (JNPR), a medium capitalization company, also provides network infrastructure equipment. 5G services, using fixed access wireless technology, are now being offered in some cities in the U.S. Google (GOOG) is a key player with its Webpass service.

Table 2: 5G Network Infrastructure Technology Companies

5G Infrastructure Component	Company
Fiber Optics	Corning (GLW), CommScope (COMM), Infineon (INFN), Cienna (CIEN), Nokia (NOK)
Base Station Cells	CommScope (COMM), Nokia (NOK)
Small Cells	CommScope (COMM)
Connectivity Products	Cisco (CSCO), Juniper Networks (JNPR)
Software and Security	Cisco (CSCO), Google (GOOG)

Smart phones: Demand for smart phones was strong during the 2012-2015 period. However, higher costs as well as lack of significant improvements in new models has led to negative growth since 2018. This trend is expected to reverse in 2020 with the advent of 5G smart phones (Figure 2). Shipments of 5G smartphones are expected to rise from 7MM or 0.5% of the total market in 2019 to 232MM or 16% of total market in 2021 (Figure 3). China is expected to be the biggest market for 5G phones with 55% of all 5G phones in 2021. Samsung, a key in smart phones, has 5G smart phones handsets available in several countries. Apple is expected to introduce three 5G smartphone in 2H 2020.

Figure 2

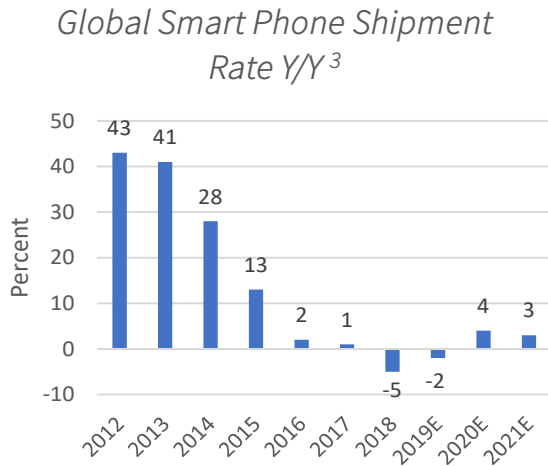
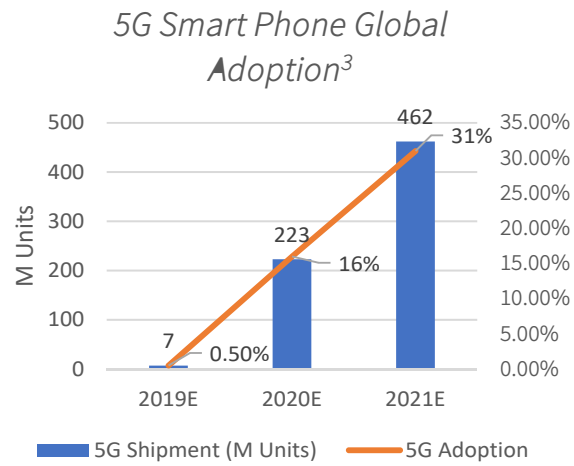


Figure 3



Mobile Chipsets: There are various chips in a typical mobile chipset (Fig 4). The two most important ones are the Application Processor chip (AP) and the modem or the baseband chip. The AP chip is considered the brain of the mobile chipset and runs all the apps like email and web browsing. The modem chip is responsible for the speed and the quality of the call. In low end cell phones both the AP chip and the modem are designed on the same chip, that is known as the system on the chip (SoC). Where as in the higher end cell phones, the two chips are separate. AAPL makes its own AP chips for all the iPhones. It recently settled its royalty dispute with Qualcomm (QCOM) and has agreed to purchase modem chips from QCOM for the next 6 years. Other smart phone manufacturers like Samsung and Hwewai also use their own AP chips in some of their cell phones and QCOM chips in the rest. QCOM is the leader in mobile chipsets (Fig 5). The connectivity chip is another essential component of the mobile chipset. It supports the Wi-Fi, Blue tooth functions of the cell phone. Broadcom (AVGO) is the leader followed by QCOM and NXP (Fig.6).

Figure 4³

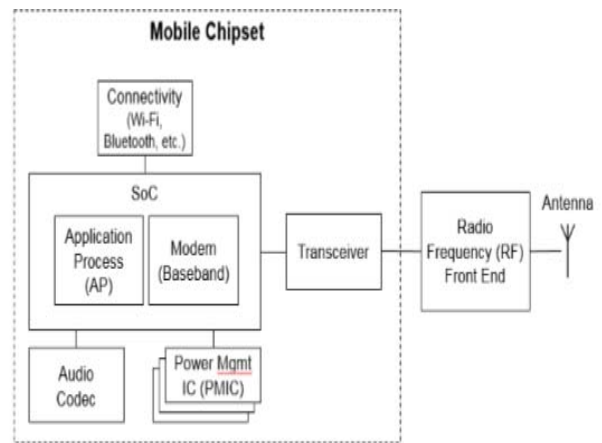


Figure 5

Mobile Chipset Market Share 2018³

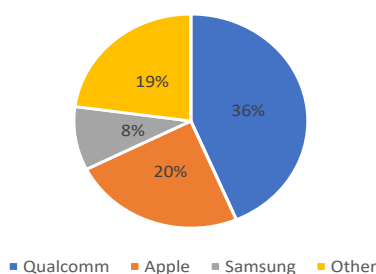
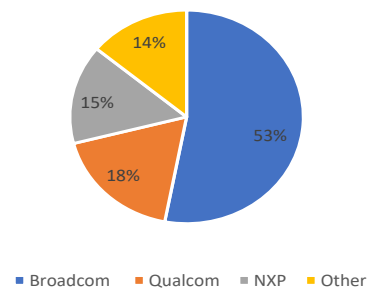


Figure 6

Mobile Connectivity Chip Market Share 2018³



Radio Frequency (RF) Components: These are needed for the transmission and reception of radio signals from electronic devices and are different from mobile chipsets. Cell phones make up about 90% of the RF component market. The market for RF components in hand sets is expected to grow 10-15% CAGR over the 2020-2022 time frame. Broadcom (AVGO) is a key player. Skyworks Solutions (SWKS) and Qorvo (QRVO) are some of the other RF component suppliers.

Edge Computing: Data requires time to travel over the fiber network and transmission towers to the network core. A significant benefit of 5G is low latency i.e. delay between transmitting and processing a message or signal. One way 5G is expected to reduce latency is by edge computing. Edge computing is collecting, storing and processing data close to the end user or the edge of the network. This eliminates the need to send data over long distance to a data center or cloud. Edge computing is possible due to the densification of the 5G network. It is expected to open new applications in manufacturing (industrial IoT) with machine learning (AI), autonomous driving and mobile gaming. NVDA and MSFT have industry specific software stacks for IoT, AI, virtual reality and cloud gaming at the edge.

Geopolitical Considerations: 5G is viewed as key for dominance in technology over the next decade. Both the U.S. and China are investing heavily to develop their infrastructure. In March 2018, Broadcom (AVGO), which was based in Singapore at the time, made a hostile bid for Qualcomm (QCOM). The current administration rejected this bid on grounds of national security and concerns that the merger would weaken QCOM, a key 5G player. Huawei, a Chinese company, is the largest network equipment company. In the trade war with China, the current administration has prohibited use of Huawei equipment in the roll out of 5G in the U.S. This is due to concerns that the Chinese government, which has significant influence over Huawei, could require it to incorporate security vulnerabilities in its equipment that could pose a national security threat. The current administration has also banned U.S. companies like Google, Xilinx and QCOM from selling their chips and operating software to Huawei. This has affected revenue growth for these companies.

The current administration has imposed tariffs on technology products that are assembled in China. Apple's (APPL) iPhones, which are all assembled in China, are currently not subject to any tariffs. However, iPhones will be subject to 15% tariffs in December 2019.

Summary

5G, the next generation wireless technology, is expected to have significantly faster speed and lower latency compared to the current 4GLTE technology. 5G is considered a breakthrough technology as it can expand wireless communication beyond smart phones to all kinds of different machines and is critical for the next industrial revolution, the Internet of Things (IoT). The roll out of the 5G network is expected to accelerate in 2020. This should benefit technology companies that supply infrastructure components. Smart phone makers and their component suppliers should also expect increased demand. Over the next couple of years, as IoT uses increase, demand for software and security for these applications will also increase. 5G is considered a key factor in technical dominance over the next decade and is currently exposed to the U.S. trade war with China. As a result, 5G related technology companies have been adversely affected and will be affected as long as the trade war continues.

References:

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2. "Infineon Technologies AG, 2018"
3. GLOBAL SEMICONDUCTORS AND TELECOMS: A 5G PRIMER: Bernstein, July 2019

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